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STATE DOCUMENTS

MONTANA STATE HIGHWAY DEPARTMENT
HIGHWAY PLANNING SURVEY
IN COOPERATION WITH
PUBLIC ROADS ADMINISTRATION

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ECONOMIC STUDY COVERING PROPOSED RELOCATION AND CONSTRUCTION OF MONTANA FOREST HIGHWAY ROUTE 46 AND IDAHO FOREST HIGHWAY ROUTE 34 (TARGHEE PASS) FROM WEST YELLOWSTONE IN MONTANA TO MACKS INN IN IDAHO

PREPARED MARCH, 1945

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MONTANA STATE HIGHWAY DEPARTMENT

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PREPARED MARCH, 1945

GENERAL OUTLINE OF STUDY

As requested by the Public Roads Administration in a letter dated January 4, 1945, an economic study has been completed on the Targhee Pass - Yellowstone Highway from Macks Inn, Idaho to West Yellowstone, Montana. The Oregon solvency quotient method was followed in making this study. This method gives the relationship between the total costs and benefits for alternate routes or methods of improving the road. In order to apply this method to a project it is assumed that the present road is inadequate and that the road must be relocated or rebuilt. As no surveys have been made, it has been necessary to assume much of the data used. Consequently, the study should be considered to be preliminary only.

A study recently made by this department in which were considered the various deficiencies of the existing highways, combined with traffic, indicates that there are 88 projects totaling 292 miles of road on the Forest Highway System in Montana that should be rebuilt before the Targhee Pass Project. But assuming the project will be built at this time, the study was made on three different proposals as follows:

1. Relocation of the road via Reas Pass
2. Reconstruction, by contract, of the road over Targhee Pass
3. Rebuilding the Targhee Pass road by maintenance forces with yearly special maintenance and betterments

The first factor considered in this study is the cost of the road. This cost is made up of the capital necessary to rebuild or reconstruct plus maintenance charges. There is considerable disagreement among economists as to whether or not interest should be charged on capital in work of this nature. This report does not attempt to settle the issue and in order that both sides of the case may be presented fairly the analysis has been made in two ways for each of the first two proposals. The question of interest does not enter into the third proposal.

Proposals number 1 and 2 were analyzed on the following basis:

(A) Capital cost including $3\frac{1}{2}\%$ interest amortized in 20 years.

(B) Capital cost with no interest, amortization in 20 years.

This highway leads to one of the principal entrances to Yellowstone National Park and is also a through route from Idaho to Montana. Due to the recreational features of the area served, the summer traffic is high compared to the winter traffic. From traffic records of the Planning Survey and the National Park Service it was found that on the present road the 1941 traffic was 788 cars per day for four summer months and 130 cars per day for eight fall and winter months. The average daily traffic for the year 1941 was 350 cars. Projecting the traffic to the year 1955, which is the average between 1945 and 1965, the average daily traffic for the summer season will be 993 and for the fall and winter season 164. The average daily traffic for the year 1955 will be 441 cars.

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http://archive.org/details/economicstudy2839mont

The ADT of 933 for the summer season indicates Standard No. 8, which will provide for traffic from 801 to 1,800 cars, should be built. There is no great difference between Standards No. 7 and No. 8. Since the traffic of 993 is only slightly over the minimum traffic of Standard No. 8 and since the roadway section generally used on Montana Federal-aid projects is 30 feet in width, with a 24 ft. surface and 9 inches of base course and 2½ inches of asphalt surfacing compares closely with Standard No. 7, this analysis has been based on Standard No. 7. The topography along either the Reas Pass or Targhee Pass is such that exceeding a 6% grade or a 6° curve will affect no appreciable saving in cost, according to estimates prepared by the Missoula office, as the roadway width and surfacing width are the same for the 40 m.p.h. and 60 m.p.h. classifications. Following are the Missoula estimates:

Standard No.	Reas Pass	Targhee Pass
0	$395,200	$365,200
1	530,000	510,400
2 & 7	629,000	621,100
3 & 8	658,900	645,900
4 & 9	703,900	687,600
5	419,100	382,100
6	566,000	548,500

It is true that costs could be reduced for these projects by building to a lower standard but we do not think a lower standard is justified. However a reduction in standards and costs will in no way affect the relative standing of the solvency quotients as in all cases the difference between the costs of the two routes is approximately the same for any particular standard.

All unit costs used to determine savings or benefits were adopted from the Oregon study since they were the best available, and since these costs were used throughout the study the comparison will be equitable in all cases.

Each proposal will now be discussed separately to clarify all factors taken into consideration.

REAS PASS

This proposal is a new location, over a pass that is 144 feet lower than Targhee Pass over which the present road passes. This route is an estimated five miles shorter than the present road, having a total length of approximately 18 miles. The cost to build this location has been estimated at $629,000.

The ADT for this route for the year 1955 will be 410 instead of 441 due to the fact that an ADT of 31 cars will remain on the present road due to local culture.

The cost to maintain this route has been determined to be $350 per mile per year. An additional maintenance charge of $50 per mile will be necessary to maintain the Targhee Pass route as a county road for the local traffic. This charge must be considered as a penalty charge against the Reas Pass location.

The various forms were then filled out based on ADT of 410. To each form is attached a detail sheet showing how the various figures on the forms were calculated. After the various items such as income, cost, and benefits had been calculated they were summarized on one sheet and the solvency quotient was calculated for each of the three analyses.

TARGHEE PASS RECONSTRUCTION

This proposal is to reconstruct the Targhee Pass road on approximately the same location, but reducing grades and curvature and rebuild to the same standard as the new location over Reas Pass. The cost estimated by the Missoula office to do this work was $621,100.

The ADT for 1955 on this road was determined to be 441 and all calculations were based on this amount of traffic.

The length of this route is 23 miles or 5 miles longer than Reas Pass location.

A set of forms was filled out for this proposal and the solvency quotient calculated in the same manner as was done for the Reas Pass location.

TARGHEE PASS - MAINTENANCE AND BETTERMENT BY STATE MAINTENANCE FORCES

Under this analysis it is proposed to make improvement in curvature, alignment, grades, base, and surface with State maintenance forces over a period of 20 years. It has been assumed that approximately 1/20 of this work would be done each year, therefore the benefits received from the road would be only 50% or the average of no benefit in the first year to full benefit at the end of 20 years.

From the study previously referred to this road is 25% deficient, therefore the cost to improve by maintenance and betterment would be 25% of $621,100 or $155,275 but due to the fact that only 1/20 of the work will be accomplished each year the cost would increase per unit. The cost increase was assumed to be 100%. Therefore, the total cost would be double this amount or $310,550. Since all the money under this

proposal would come from current income no interest charges were added to the total cost.

The income from traffic was figured on an ADT of 441 the same as proposal two.

A set of forms were filled out on the above figures and the solvency quotient calculated.

SUMMARY

When the solvency quotient is unity the project is solvent but not surplus producing. If it is greater than one, a surplus will be created for extensions or improvements. If it is less than unity the project cannot be justified on economic grounds alone.

Following is a tabulation of the different quotients obtained from the different analyses of the three proposals.

The addition of Iar + Bn + Bf divided by the annual cost represents the actual solvency of the route, for example for proposal number 1

$$\frac{16,300 + 44,564 + 17,709}{51,731} = 1.51$$

on the other hand, Qc = 1.02 represents the composite benefits to the road users and the state.

SOLVENCY RESULTS

	Reas Pass Location		Targhee Pass Reconst.		Maintenance & Betterments
	A	B	A	B	A
Qs - Financial Income	0.32	0.42	0.43	0.57	0.86
QBn - Non-fuel Savings	0.86	1.15	0.11	0.15	0.11
QBf - Fuel Savings	0.34	0.46	0.05	0.06	0.05
Actual Solvency	1.51	2.01	0.59	0.78	1.02
Composite Solvency	1.02	1.36	0.42	0.55	0.72

A = Capital cost including $3\frac{1}{2}\%$ interest amortized in 20 years.

B = Capital cost with no interest, amortized in 20 years.

Thus it is indicated that if the project is reconstructed the Reas Pass location with actual solvencies of 1.51 with interest and 2.01 without interest is the soundest proposal as the Targhee Pass reconstruction has actual solvencies of 0.59 and 0.78 respectively, while the maintenance and betterment proposal has an actual solvency of only 1.02 in addition to being in a more or less unsatisfactory condition throughout the 20 year period.

It should be understood, however, that these actual solvencies represent the solvency of one route as compared to the others as determined from the total income and road users benefits. The study, of course, is not concerned with the fact as to whether or not there is sufficient traffic over the project to justify its construction in the first place from a financial standpoint. In fact, there is very little mileage on the Federal-Aid System in Montana that produces sufficient income to pay the cost of construction and maintenance.

As stated in the beginning, this study was undertaken at the request of the Public Roads Administration and was made by P. M. Johnson, Office Engineer for the Highway Traffic & Planning Survey, assisted by the technical advice and recommendations of the State and Public Roads Highway Planning Survey Managers.

ANALYSIS
GENERAL INFORMATION

Location The section of the road studied is from the West Entrance of Yellowstone National Park southwesterly to Macks Inn, Idaho. It is on the following highway system:

National Forest System:

Montana portion 9.4 miles, Montana Forest Highway Route #46

Idaho portion 13.6 miles, Idaho Forest Highway Route #34

Federal Aid System;

Montana portion 9.4 miles, Federal-Aid Route #14

Idaho portion 13.6 miles, Federal-Aid Route # ?

U. S. Highway System:

Montana portion 9.4 miles, U. S. Highway #191

Idaho portion 13.6 miles, U. S. Highway #191

Traffic

TARGHEE PASS

Average daily traffic .... 1941 ... 350

Average daily traffic 4 months summer .... 1941 ... 788

Average daily traffic balance of year .... 1941 ... 130

Average daily traffic 4 months summer .... 1955 ... 993

Average daily traffic balance of year .... 1955 ... 164

Average daily traffic 12 months .... 1955 ... 441

1955 is the average between the years 1945 and 1965 -- the period over which amortization was calculated.

Average Daily Traffic

Year	Passenger Cars		Trucks						
	Local	Foreign	Light	Med.	Heavy	Semi Trailer	Full Trailer	Busses	Total
1941	144	119	53	5	0	27	1	1	350
1955	181	150	66	6	1	34	1	2	441

Percent passenger cars 75.0% Trucks 25.0% 1955

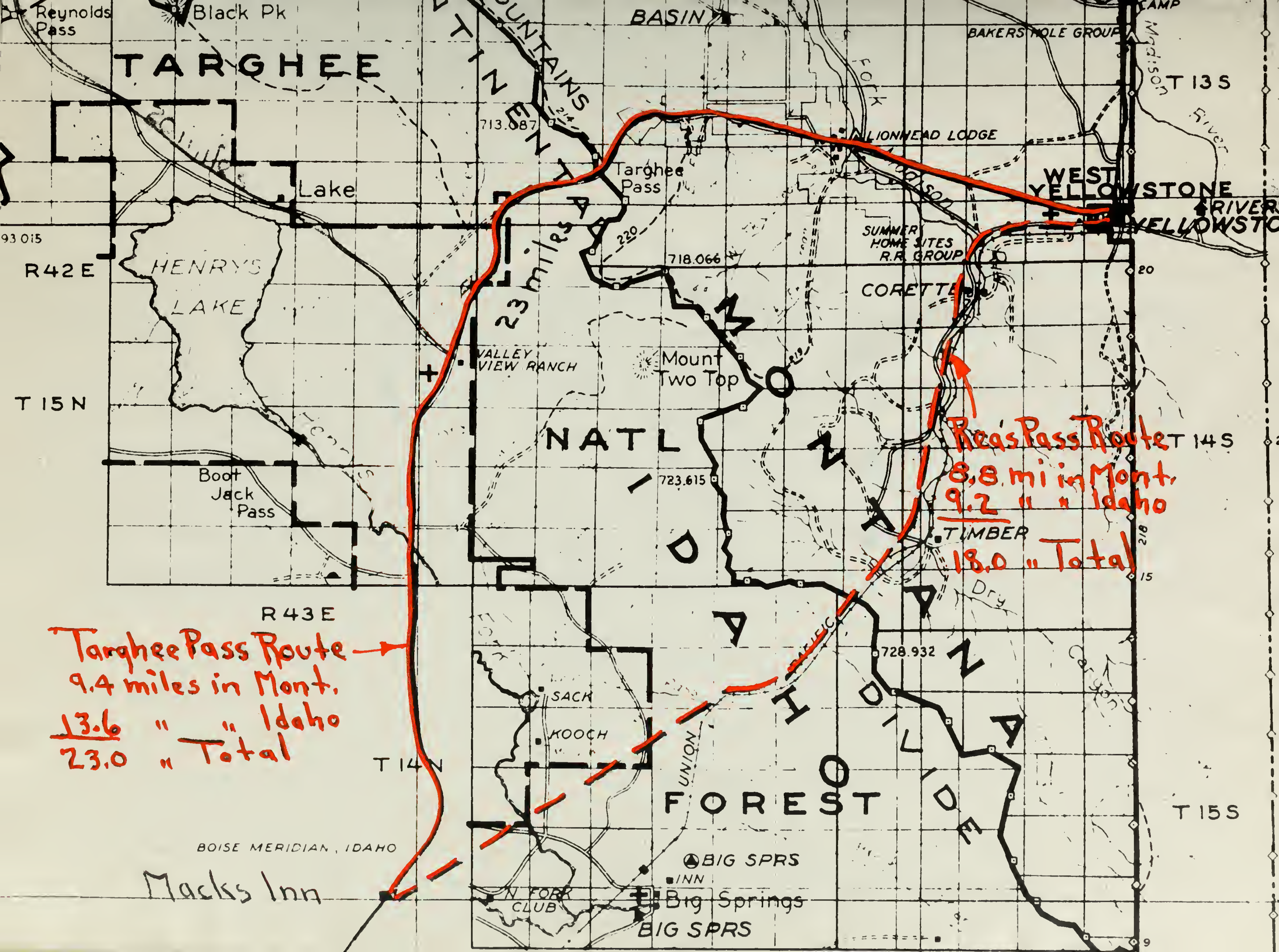
REAS PASS

Average Daily Traffic									
Year	Passenger Cars		Trucks						
	Local	Foreign	Light	Med.	Heavy	Semi Trailer	Full Trailer	Busses	Total
1955	168	139	62	6	1	32	1	1	410

Percent passenger cars 74.9% Trucks 25.1%, 1955

Average Weights of Passenger Cars and Trucks
(Determined from 1944 Montana Loadometer Survey)

Passenger cars	1.50 tons
Trucks, Light	3.27 tons
Trucks, Medium	6.88 tons
Trucks, Heavy	11.15 tons
Trucks, with Semi Trailer	14.89 tons
Trucks, with Trailer	22.76 tons
Busses	9.00 tons (Estimated)



23 miles

Reas Pass Route
8.8 mi in Mont.
9.2 " " Idaho
18.0 " Total

Targhee Pass Route
9.4 miles in Mont.
13.6 " " Idaho
23.0 " Total

Macks Inn

Montana State Highway Department
Traffic and Planning Section
Public Roads Administration
Basic Design Categories
Table No. 1

Standard	Average Daily Traffic	Classification	Max. Grade	Max. Curvature (Degree)	Sight Distance				Shoulder Width	Width of Road Bed at Grade	Width of Surfacing	Minimum Type of Surfacing	Minimum Base Course
					Non Passing			Passing					
					Horiz. Curvature (Degree)	Vertical Curvature (Algebraic Difference)	Feet	Feet					
0	0-200	20 M 40	7	14	14		280	800	3	24	18	Under 1" Oil	5"
1	201-400	50 M 40	7	14	14		290	800	4	28	20	2" Oil	6"
2	401-800	100 M 40	7	14	14		310	1100	5	32	22	2½" Oil	8"
3	801-1800	200 M 40	7	14	14	SEE TABLE NO. 2.	320	1100	6	34	22	2½" Oil	8"
4	1801-3500	300 M 40	7	14	14		330	1100	8	38	22	2½" Oil	8"
5	0-200	20 M 60	6	6	6		460	1700	3	26	20	Under 1" Oil	5"
6	201-400	50 M 60	6	6	6		460	1700	4	30	22	2" Oil	6"
7	401-800	100 M 60	6	6	6		470	2100	5	32	22	2½" Oil	8"
8	801-1800	200 M 60	6	6	6		480	2100	6	34	22	2½" Oil	8"
9	1801-3500	300 M 60	6	6	6		500	2100	8	38	22	2½" Oil	8"

Note: Roads having over 3500 vehicles per day require special design.

TABLE NO. 2

Table giving length of vertical curve required for various Non - passing sight distances

December 18, 1943

Algebraic Difference between grades for convex curvature.	Length of vertical curve for a Non-passing sight distance of: 280 feet	Length of vertical curve for a Non-passing sight distance of: 290 feet	Length of vertical curve for a Non-passing sight distance of: 310 feet	Length of vertical curve for a Non-passing sight distance of: 320 feet	Length of vertical curve for a Non-passing sight distance of: 330 feet	Length of vertical curve for a Non-passing sight distance of: 460 feet	Length of vertical curve for a Non-passing sight distance of: 470 feet	Length of vertical curve for a Non-passing sight distance of: 480 feet	Length of vertical curve for a Non-passing sight distance of: 500 feet
1.00	96	103	117	125	133	258	269	281	305
2.00	191	205	234	250	266	516	539	562	610
3.00	287	308	352	375	398	774	808	843	915
4.00	382	410	469	500	531	1032	1078	1124	1220
5.00	478	513	586	624	664	1290	1347	1405	1524
6.00	574	615	703	749	797	1548	1616	1686	1829
7.00	669	718	820	874	930	1806	1886	1967	2134
8.00	765	820	938	999	1062	2064	2155	2248	2439
9.00	860	923	1055	1124	1195	2322	2425	2529	2744
10.00	956	1026	1172	1249	1328	2581	2694	2810	3049
11.00	1052	1128	1289	1374	1461	2839	2963	3091	3354
12.00	1147	1231	1406	1499	1594	3097	3233	3372	3659
13.00	1243	1333	1524	1623	1726	3355	3502	3653	3963
14.00	1339	1436	1641	1748	1859	3613	3771	3934	4268

REA'S PASS
RELOCATION ANALYSIS

REAS PASS -- NEW LOCATION

HIGHWAY PROJECT ANALYSIS

Location of project Montana & Idaho County Gallatin & Fremont

Description of project Reas Pass - West Yellowstone - Macks Inn

Highway number Idaho FH #34 Mont. FH #46 Highway system Forest Hwy. & Federal-Aid

Length 18.0 miles Date of analysis March, 1945

Analysis made by P. M. Johnson Checked by

	A	B		A	B
I_{ar} = $	16,300	16,300	K_1 =	1	1
C_a = $	51,731	38,900	K_2 =	0.93	0.93
B_n = $	44,564	44,564	K_3 =	0.25	0.25
B_f = $	17,709	17,709	K_2K_3 =	0.2325	
K_1C_a = $	51,731	38,900	$1-K_2K_3$ =	0.7679	

$Q_s = I_{ar}/K_1C_a =$ (A) $\frac{16300}{51731} = 0.32$ (B) $\frac{16300}{38900} = 0.42$

$Q_{Bn} = B_n/K_1C_a =$ (A) $\frac{44564}{51731} = 0.86$ (B) $\frac{44564}{38900} = 1.15$

$Q_{Bf} = B_f/K_1C_a =$ (A) $\frac{17709}{51731} = 0.34$ (B) $\frac{17709}{38900} = 0.46$

$Q'_s = Q_s - K_2K_3Q_{Bf} =$ (A) $0.32 - (0.34 \times 0.2325) = 0.24$ (B) $0.42 - (0.46 \times .2325) = 0.31$

$Q_c = 0.707 \cdot (Q_s + Q_{Bn} + Q_{Bf}(1-K_2K_3)) =$ (A) $.707\ (0.32 + 0.86 + (0.34 \times .7679)) = 1.02$

(B) $.707\ (0.42 + 1.15 + (0.46 \times .7679)) = 1.36$

A = 100% Road users funds amortized in 20 yrs. @ 3½% interest

B = 100% Road users funds amortized in 20 yrs. No interest.

ANNUAL COST
CALCULATIONS

HIGHWAY PROJECT ANALYSIS

Location of project Montana & Idaho County Gallatin & Fremont

Description of project Reas Pass - West Yellowstone - Macks Inn

Highway number Idaho F.H. #34
Montana F.H. #46 Highway system Forest Hwy. & Federal-Aid

Length 18.0 miles Date of analysis March, 1945

CAPITAL COSTS

Item	Net Cost	Gross* Cost	Amort. Period	Annual Capital Cost
Rights of way, easements, etc.	$	$		$
Clearing, grading, etc.				
Pavements and surfacing:				
Type ______ , ________ Mi.				
Type ______ , ________ Mi.				
Structures:				
Type ______ , ________ Ft.				
Type ______ , ________ Ft.				
Type ______ , ________ Ft.				
Signs, lights, signals etc....				
Other Construction items:.....				
Unamortized cost old const....				
1. Total annual capital cost.	551,750...	629,000..	20 yr. 3½%..	$ 44,281
		629,000	No Interest	31,450

MAINTENANCE COSTS

Item		Net Cost	Gross** Cost
Pavements and roadway surfaces:			
Type ____________ ,	______ Mi.	$	$
Type ____________ ,	______ Mi.		
Roadbed, shoulders and right of way	______ Mi.		
Structures:			
Type ____________ ,	______ Ft.		
Type ____________ ,	______ Ft.		
Type ____________ ,	______ Ft.		
Miscellaneous general maintenance			
Other items			$
2. Total annual maintenance cost	18 miles @ 350.00		$ 6,300
	23 miles @ 50.00		1,150

OPERATION COSTS

3. Additional mileage ________ at ________ per mile $ ________

TOTAL ANNUAL COSTS (1 + 2 + 3) ________ 51,731 Interest
$ 38,900 No Interest

*Gross costs comprise net costs plus 10% for engineering and construction and 4% for general administration and overhead.

**Gross costs comprise net costs plus 6% for general administration and overhead expense.

REAS PASS
NEW LOCATION
CAPITAL COST DETAILS

Total cost estimated at $629,000

14% = Engr., adm. & overhead cost

$\frac{629000}{114} \times 100 =$ \$551,750 = net cost

Using 3½% interest over a 20 year period

See page 109
TB #7 Oregon (1937) $\frac{Cao}{c}$ from chart = .0704

629000 x .0704 = \$44,281 = annual capital cost

Using no interest:
$\frac{629000}{20} =$ 31,450 = annual capital cost

Maintenance charge = \$350 per year

350 x 18 = \$ 6,300.00
44281 + 6300 = 50,581.00
31450 + 6300 = 37,750.00

Maintain the Targhee Pass Road as County Road

23 Mi. @ \$50 per mile = \$1,150.00 per year

50,581 + 1150 = \$51,731 Total annual cost with interest

37,750 + 1150 = 38,900 Total annual cost without interest

HIGHWAY PROJECT ANALYSIS

Location of project Mont. & Idaho Description of project Reas Pass County Gallatin & Fremont

Highway Idaho FH #34 / Mont. FH #46 Highway System Forest Hwy. & Federal-Aid Length 18.0 Date of analysis March, 1945

Traffic Type	Average Annual Traffic				Average Annual Road Use During Life of Project		Unit Net Revenues		Total Annual Net Revenue
	Present		Projected				Per Vehicle Mi	Per Ton Mile	
	Vehicles	Tons	Vehicles 1955	Tons	Veh. Miles	Ton Mi.	Dollars	Dollars	Dollars
Passenger Cars-~~Oregon~~ Mont.			61,320	91,980	1,103,760	1,655,640	0.003391	0.002188	3,622
Cars - Foreign			50,735	76,102	913,230	1,369,836	0.002758	0.001779	2,437
Total passenger cars			112,055	168,082	2,016,990	3,025,476	--	--	6,059
Trucks, light			22,630	74,000	407,340	1,332,000	0.011044	0.003248	4,326
Trucks, medium			2,190	15,067	39,420	271,206	0.015480	0.002382	646
Trucks, heavy			365	4,070	6,570	73,260	0.016190	0.001619	119
Trucks, semi-trailer			11,680	173,915	210,240	3,130,470	0.015430	0.001513	4,830
Trucks, full-trailer			365	8,307	6,570	149,526	0.023732	0.001396	209
Busses, school			--	--	--	--	--	--	--
Busses, other			365	3,285	6,570	59,130	0.016857	0.001873	111
Total trucks & busses			37,595	278,644	676,710	5,015,592	--	--	10,241
Total all vehicles			149,650	446,726	2,693,700	8,041,068	--	--	16,300

Average weight of trucks 7.41 tons; All vehicles ______ tons. Total Annual Income.... 16,300

Percentage truck traffic 25.1 .

Amortization period 20 years.

HIGHWAY PROJECT ANALYSIS

Location of project Mont. & Idaho County Gallatin & Fremont
Description of project Reas Pass - West Yellowstone - Macks Inn
Highway number Idaho FH 34, Mont FH 46 Highway System Forest Hwy. & Federal-Aid
Length 18.0 miles Date of analysis March, 1945

	Routes		
	A	B	C
Annual Traffic Volume			
Private Passenger cars (per year)	112,055		
Trucks, light (per year)........	22,630		
Trucks, medium (per year).......	2,190		
Trucks, heavy (per year)........	12,775		
Busses (per year)...............			
Other traffic...................			
Totals..................	149,650		
Private Passenger Cars			
Average speed (miles per hour)..	43	43	
Distance (Miles)................	18	23	
Time (hours per trip)...........	.418	.534	
Time savings per vehicle........	.116		
Value of savings($/vehicle-hour)	$0.60		
Annual traffic volume...........	112,055		
Value of time savings...........	7,799		
Total..................	$		
Trucks, Light			
Average speed (miles per hour)..	39	35	
Distance (miles)................	18	23	
Time (hours per trip)...........	.461	.657	
Time savings per vehicle........	.196		
Value of savings ($/vehicle-hour)	$0.86		
Annual traffic volume...........	22,630		
Value of time savings...........	3,814		
Total..................	$		
Trucks, Medium			
Average speed (miles per hour)..	35	31	
Distance (miles)................	18	23	
Time (hours per trip)...........	.514	.741	
Time savings per vehicle........	.227		
Value of savings ($/vehicle-hour)	$1.17		
Annual traffic volume...........	2,190		
Value of time savings...........	582		
Total..................	$ 582		
Trucks, Heavy			
Average speed (miles per hour)..	32	28	
Distance (miles)................	18	23	
Time (hours per trip)...........	.562	.821	
Time savings per vehicle........	.259		
Value of savings ($/vehicle-hour)	$1.47		
Annual traffic volume...........	12,775		
Value of time savings...........	4,864		
Total..................	$		
Busses			
Average speed (miles per hour)..			
Distance (miles)................			
Time (hours per trip)...........			
Time savings per vehicle........			
Value of savings ($/vehicle-hour)			
Annual traffic volume...........			
Total..................	$		

TOTAL ANNUAL TIME ELEMENT SAVINGS .... $ 17,059

REAS PASS
NEW LOCATION
TIME ELEMENT SAVING DETAILS

Passenger cars:

Page 433 (1937 Speed constant for all grades.

$$Ts = \frac{23}{43} - \frac{18}{43} = .534 - .418 = .116$$

112,055 x .116 x $ 0.60 = $7,799

Trucks (light):

Page 433 (1937) 1% grade - type 483 surfact speed = 39 m.p.h.

New route alignment = 10
Existing route alignment = 6
Point saving = 4

4 x 1.0 = 4 miles per hr. reduction made on account of alignment

Speed on existing route = 39 - 4 = 35

$$Ts = \frac{23}{35} - \frac{18}{39} = .657 - .461 = .196$$

22,630 x .196 x $0.86 = $3,814 Saving

Trucks (medium)

Page 433 (1937) From chart speed = 35 m.p.h.
Correct for alignment same as above 35 - 4 = 31 m.p.h.

$$T = \frac{23}{31} - \frac{18}{35} = .741 - .514 = .227$$

2,190 x .227 x 1.17 = $582 Saving

Trucks (heavy)

Page 433 (1937) From chart speed = 32 m.p.h.
Correct for alignment as above 32 - 4 = 28 m.p.h.

$$T = \frac{23}{28} - \frac{18}{32} = .821 - .562 = .259$$

12,775 x .259 x 1.47 = $4,864 Saving

Total Saving = 7,799 + 3,814 + 582 + 4,864 = $17,059

Mileage Element Savings

HIGHWAY PROJECT ANALYSIS

Location of project Montana & Idaho County Gallatin & Fremont
Description of Project Reas Pass - West Yellowstone - Macks Inn
Highway number Idaho FH 34, Mont FH 46 Highway system Forest Hwy & Federal-Aid
Length 18.0 Date of Analysis March, 1945

	Routes		
	A NEW	B EXISTING	C
Distance			
Length (miles)....................	18.0	23.0	
Distance saving (miles)..........	5.0		
Average annual traffic (tons)....	446,726		
Annual traffic saving (ton-mi.)..	2,233,630		
Cost ($/ton-mile)................	$0.0187		
Annual saving....................	$41,769		
Total....................	$		
Surface			
Roadway surface type.............	483	483	
Saving coefficient...............	0		
Aver. annual traffic (ton-mi.)...			
Saving ($/ton-mile)..............			
Annual Saving....................			
Total....................	$		
Rise and Fall			
Rise and fall (feet).............	1649	1799	
Saving (feet)....................	150		
Saving (foot-tons)...............	67,008,900		
Saving ($/foot-ton)..............	3.42×10^{-6}		
Annual saving....................	229		
Total....................	$		
Gradient			
Gradients in per cent............	.84	.98	
Red'n in gradient................	.14		
Average An. traffic (ton-mi.)....			
Saving ($/ton-mile)..............			
Annual saving....................	0		
Total....................	$		
Alignment			
Curvature rating.................	10	6	
Points improvement...............	4		
Saving (point-ton-miles).........	32,164,272		
Saving ($/point-ton-mile)........	$0.001		
Annual saving....................	3,216		
Total....................	$		
Traffic Stops			
Number per year..................			
Eliminated per year..............			
Aver. vehicular weight (tons)....			
Saving ($ per ton-per stop)......			
Annual saving....................			
Total....................	$		

TOTAL ANNUAL MILEAGE ELEMENT SAVINGS $ 45,214

REAS PASS
NEW LOCATION
MILEAGE ELEMENT SAVINGS DETAILS

Distance

Cost ton mile:
Passenger car = 2.07 cents per mile -- page 385 TB #7 Oregon (1937)

Gross weight for trucks this project
Light - 62 x 3.27 = 202.7 tons
Medium - 6 x 6.88 = 41.3 "
Heavy - 1 x 11.15 = 11.2 "
Semi. Tr - 32 x 14.89 = 476.5 "
Full Tr. -- 1 x 22.76 = 22.8 "
Busses - 1 x 9.00 = 9.0 "
103 763.5 = 7.41 ton average
14, 820 pounds average

$\frac{103}{410}$ = 25.1% of traffic = trucks

From Chart 113, page 388 (TB #7 Oregon) (1937)

Operating cost for 14,820 pound gross weight = 1.29 cents per T. mile

Passenger cars = .749 x 2.07 = 1.55
Trucks = .251 x 1.29 = 0.32
Combined cost in cents per T. mile 1.87

Surface

Both roads have or to have type 483 surface -- so no saving effected.

Rise and Fall

Existing road has 1,799 ft. of rise and fall. New location will eliminate at least 150 ft. of rise and fall due to lower elevation of Reas Pass.

446,726 x 150 = 67,008,900 foot tons (Traffic Sheet)

74.9% = Pass. Traffic
25.1% = Truck Traffic with average weight = 14,820 pounds

$74.9 \times 3.72 \times 10^{-6} = 2.79 \times 10^{-6}$
$25.1 \times 2.50 \times 10^{-6} = .63 \times 10^{-6}$ Page 410 TB #7 Oregon (1937)
3.42×10^{-6}
67,008,900 x .00000342 = $229.00

Gradient

The gradient of both routes is so close to 1% that the difference can be neglected. Therefore, the annual saving for the item is 0.

Alignmnet

446,726 x 18 x 4 = 32,164,272 Point - Ton-Miles saving

32,164,272 x $0.001 = $3,216 Page 417 (TB #7 Oregon 1937)

Traffic Stops

None

Total = 41,769 + 229 + 3,216 = $45,214

HIGHWAY PROJECT ANALYSIS

Location of project Montana & Idaho County Gallatin & Fremont

Description of project Reas Pass - West Yellowstone - Macks Inn

Highway number Idaho FH #34 Mont. FH 46 Highway system Forest Hwy. & Federal-Aid

Length 18.0 Miles Date of analysis March, 1945

Mileage Element Factors

Item	Fuel Function	Non-fuel Function
Distance savings	$ 15,872	$ 25,897
Roadway surface savings	0	0
Rise and fall savings	229	0
Gradient savings	0	0
Alignment savings	1,608	1,608
Elimination of traffic stops		
Miscellaneous savings		
Total Mileage Savings	$ 17,709	$ 27,505

Time Element Factors / Other Benefit Items

Type of Traffic	Annual Value of Time Savings	Item	Value
Passenger cars	$ 7,799		$
Trucks, light	3,814		
Trucks, medium	582		
Trucks, heavy	4,864		
Busses			
Total Time Savings	$ 17,059	Total	$

Recapitulation of Annual Benefits

Total Fuel Function Benefits $ 17,709

Non-fuel function benefits	(Mileage element factors	$ 27,505
	(Time element factors	17,059
	(Other benefit items	$

Total Non-fuel Function Benefits $ 44,564

TOTAL ANNUAL BENEFITS 62,273

REAS PASS
NEW LOCATION
TRAFFIC BENEFITS DETAILS

Distance Saving - Fuel & Non-fuel function

See page 438 (1937)
38% = fuel saving
62% = non-fuel saving

Surface Saving - See page 439 - 0 in this case

Rise & Fall Saving
See page 439 (1937) 100% fuel function

Gradient Saving
See page 439 (1937) 0 in this case

Alignment Saving
See page 440 (1937) 50% fuel function

Elimination of Traffic Stops
See page 440 (1937) 0 in this case

TARGHEE PASS
RECONSTRUCTION ANALYSIS

TARGHEE PASS - RECONSTRUCTION
HIGHWAY PROJECT ANALYSIS

Location of project Montana & Idaho County Gallatin & Fremont

Description of project Targhee Pass - West Yellowstone - Macks Inn

Highway number Idaho FH #34
Mont. FH #46 Highway system Forest Hwy. - Federal-Aid

Length 23.0 miles Date of analysis March, 1945

Analysis made by P.M. Johnson Checked by

	A	B		A	B
I_{ar} =	\$22,317	22,317	K_1 =	1	1
C_a =	\$51,775	39,105	K_2 =	0	0
B_n =	\$ 5,899	5,899	K_3 =		
B_f =	\$ 2,367	2,367	K_2K_3 =		
K_1C_a =	\$51,775	39,105	$1-K_2K_3$ =		

$Q_s = I_{ar}/K_1C_a =$ (A) $\frac{22317}{51775} = 0.43$ (B) $\frac{22317}{39105} = 0.57$

$Q_{Bn} = B_n/K_1C_a =$ (A) $\frac{5899}{51775} = 0.11$ (B) $\frac{5899}{39105} = 0.15$

$Q_{Bf} = B_f/K_1C_a =$ (A) $\frac{2367}{51775} = 0.05$ (B) $\frac{2367}{39105} = 0.06$

$Q'_s = Q_s - K_2K_3Q_{Bf} =$ $Q'_s = Q_s$

$Q_c = 0.707\,(Q_s + Q_{Bn} + Q_{Bf}(1-K_2K_3)) =$ (A) .707 (0.43 + 0.11 + 0.05) = 0.42

(B) .707 (0.57 + 0.15 + 0.06) = 0.55

A = 100% Road users funds amortized in 20 yrs. @ 3½% interest

B = 100% Road users funds amortized in 20 yrs. no interest.

ANNUAL COST
CALCULATIONS

TARGHEE PASS - RECONSTRUCTION
HIGHWAY PROJECT ANALYSIS

Location of project Montana and Idaho County Gallatin & Fremont

Description of project Targhee Pass - West Yellowstone - Macks Inn

Highway number Idaho FH #34 Mont. FH #46 Highway system Forest Hwy. & Federal-Aid

Length 23.0 miles Date of analysis March, 1945

CAPITAL COSTS

Item	Net Cost	Gross* Cost	Amort. Period	Annual Capital Cost
Rights of way, easements, etc.	$	$		$
Clearing, grading, etc.				
Pavements and surfacing:				
Type ____, ____ Mi.				
Type ____, ____ Mi.				
Structures:				
Type ____, ____ Ft.				
Type ____, ____ Ft.				
Type ____, ____ Ft.				
Signs, lights, signals etc....				
Other Construction items:.....				
Unamortized cost old const....				
1. Total annual capital cost.	544,824 ..	621,100 ..	20 Yr.. 3.5%	$ 43,725
		621,100	No. Int.	31,055

MAINTENANCE COSTS

Item		Net Cost	Gross** Cost
Pavements and roadway surfaces:			
Type ____,	____ Mi.	$	$
Type ____,	____ Mi.		
Roadbed, shoulders and right of way	____ Mi.		
Structures:			
Type ____,	____ Ft.		
Type ____,	____ Ft.		
Type ____,	____ Ft.		
Miscellaneous general maintenance			
Other items			$
2. Total annual maintenance cost 23 mi. @ 350			$ 8,050

OPERATION COSTS

3. Additional mileage ____ at ____ per mile $ ____

TOTAL ANNUAL COSTS (1 + 2 + 3) ____ $ 51,775 Interest
39,105 No Interest

---

*Gross costs comprise net costs plus 10% for engineering and construction and 4% for general administration and overhead.

**Gross costs comprise net costs plus 6% for general administration and overhead expense.

HIGHWAY PROJECT ANALYSIS

Traffic Income

Location of project Montana & Idaho Description of project Targhee Pass County Gallatin & Fremont

Highway Idaho FH #34 Mont. FH #46 Highway System Forest Hwy. Federal-Aid Length 23.0 Date of analysis March, 1945

Traffic Type	Average Annual Traffic Present Vehicles: 1941	Average Annual Traffic Present Tons	Average Annual Traffic Projected Vehicles 1955	Average Annual Traffic Projected Tons	Average Annual Road Use During Life of Project Veh.Miles	Average Annual Road Use During Life of Project Ton Mi.	Unit Net Revenues Per Vehicle Mi: Dollars	Unit Net Revenues Per Ton Mile Dollars	Total Annual Net Revenue Dollars
Passenger Cars-~~Oregon~~ Mont.	52,560	78,840	66,065	99,098	1,519,495	2,279,254	0.003391	0.002188	4,987
Cars - Foreign	43,435	65,153	54,750	82,125	1,259,250	1,888,875	0.002758	0.001779	3,360
Total passenger cars	95,995	143,993	120,815	181,223	2,778,745	4,168,129	--	--	8,347
Trucks, light	19,345	63,258	24,090	78,774	554,070	1,811,802	0.011044	0.003248	5,885
Trucks, medium	1,825	12,556	2,190	15,067	50,370	346,541	0.015480	0.002382	825
Trucks, heavy	--	--	365	4,070	8,395	93,610	0.016190	0.001619	152
Trucks, semi-trailer	9,855	146,740	12,410	184,785	285,430	4,250,055	0.015430	0.001543	6,558
Trucks, full-trailer	365	8,307	365	8,307	8,395	191,061	0.023732	0.001396	267
Busses, school	--	--	--	--	--	--	--	--	--
Busses, other	365	3,285	730	6,570	16,790	151,110	0.016857	0.001873	283
Total trucks & busses	31,755	234,146	40,150	297,573	923,450	6,844,179	--	--	13,970
Total all vehicles	127,750	378,139	160,965	478,796	3,702,195	11,012,308	--	--	22,317

Average weight of trucks 7.42 tons; All vehicles ______ tons. Total Annual Income....$ 22,317

Percentage truck traffic 25.0.

Amortization period 20 years.

TARGHEE PASS - RECONSTRUCTION   Time Element Savings

HIGHWAY PROJECT ANALYSIS

Location of project Mont. & Idaho   County Gallatin & Fremont
Description of project Targhee Pass - West Yellowstone - Macks Inn
Highway number Mont. FH 46, Idaho FH 34   Highway System Forest Hwy., & Federal-Aid
Length 23.0 miles   Date of analysis March, 1945

	Routes		
	A NEW	B EXISTING	C
Annual Traffic Volume			
Private Passenger cars (per year)	120,815	120,815	
Trucks, light (per year)........	24,090	24,090	
Trucks, medium (per year).......	2,190	2,190	
Trucks, heavy (per year)........	13,870	13,870	
Busses (per year)...............			
Other traffic...................			
Totals.................			
Private Passenger Cars			
Average speed (miles per hour)..	43	43	
Distance (Miles)................	23	23	
Time (hours per trip)...........	.534	.534	
Time savings per vehicle........	0		
Value of savings ($/vehicle-hour)	$0.60		
Annual traffic volume...........	120, 815		
Value of time savings...........	0		
Total..................	$		
Trucks, Light			
Average speed (miles per hour)..	39	35	
Distance (miles)................	23	23	
Time (hours per trip)...........	.590	.657	
Time savings per vehicle........	.067		
Value of savings ($/vehicle-hour)	$0.86		
Annual traffic volume...........	24,090		
Value of time savings...........	1,388		
Total..................	$ 1,388		
Trucks, Medium			
Average speed (miles per hour)..	35	31	
Distance (miles)................	23	23	
Time (hours per trip)...........	.657	.741	
Time savings per vehicle........	.084		
Value of savings ($/vehicle-hour)	$1.17		
Annual traffic volume...........	2,190		
Value of time savings...........	215		
Total..................	$ 215		
Trucks, Heavy			
Average speed (miles per hour)..	32	28	
Distance (miles)................	23	23	
Time (hours per trip)...........	.719	.821	
Time savings per vehicle........	.103		
Value of savings ($/vehicle-hour)	$1.47		
Annual traffic volume...........	13,870		
Value of time savings...........	2,094		
Total..................	$ 2,094		
Busses			
Average speed (miles per hour)..			
Distance (miles)................			
Time (hours per trip)...........			
Time savings per vehicle........			
Value of savings ($/vehicle-hour)			
Annual traffic volume...........			
Total..................	$		

TOTAL ANNUAL TIME ELEMENT SAVINGS .... $ 3,697

TARGHEE PASS - RECONSTRUCTION

Mileage Element Savings

HIGHWAY PROJECT ANALYSIS

Location of project Montana & Idaho County Gallatin & Fremont
Description of Project Targhee Pass - West Yellowstone - Macks Inn
Highway number Mont FH 46, Idaho FH 34 Highway system Forest Hwy. - Federal-aid
Length 23.0 Date of Analysis March, 1945

	Routes A NEW	B EXISTING	C
Distance			
Length (miles)....................	23	23	
Distance saving (miles)..........			
Average annual traffic (tons)....			
Annual traffic saving (ton-mi.)..			
Cost ($/ton-mile)................			
Annual saving....................			
Total....................	$ None		
Surface			
Roadway surface type.............	483	483	
Saving coefficient...............			
Aver. annual traffic (ton-mi.)...			
Saving ($/ton-mile)..............			
Annual Saving....................			
Total....................	$ None	None	
Rise and Fall			
Rise and fall (feet).............	1,699	1,799	
Saving (feet)....................	100		
Saving (foot-tons)...............	47,879,600		
Saving ($/foot-ton)..............	3.42×10^{-6}		
Annual saving....................	164		
Total....................	$ 164		
Gradient			
Gradients in per cent............	.98	.98	
Red'n in gradient................	0		
Average An. traffic (ton-mi.)....			
Saving ($/ton-mile)..............			
Annual saving....................			
Total....................	$ None		
Alignment			
Curvature rating.................	10	6	
Points improvement...............	4		
Saving (point-ton-miles).........	44,049,232		
Saving ($/point-ton-mile)........	$0.0001		
Annual saving....................			
Total....................	$4,405		
Traffic Stops			
Number per year..................			
Eliminated per year..............			
Aver. vehicular weight (tons)....			
Saving ($ per ton-per stop)......			
Annual saving....................			
Total....................	$None		

TOTAL ANNUAL MILEAGE ELEMENT SAVINGS $4,569

TARGHEE PASS - RECONSTRUCTION
MILEAGE ELEMENT SAVINGS DETAILS

Distance: Reconstructing road on present general alignment will not decrease distance.

Surface:

Reconstructed surface to be same as existing surface -- Type 483.

Rise & Fall:

In reconstructing it is estimated that 100' of rise and fall will be eliminated.

478,796 tons (from traffic sheet)
478,796 x 100 = 47,879,600 foot-tons

75.0% = pass. traffic
25.0% = truck traffic with gross weight of 14,840 pounds

$$\begin{array}{l} 75.0 \times 3.72 \times 10^{-6} = 2.79 \times 10^{-6} \\ 25.0 \times 2.50 \times 10^{-6} = \underline{0.63 \times 10^{-6}} \\ \qquad\qquad\qquad\qquad\quad 3.42 \times 10^{-6} \end{array}$$

Page 410 TB #7 Oregon (1937)

47,879,600 x .00000342 = $164.00

Gradient:

There will be no difference in gradient of the reconstructed road in comparison with present road.

Alignment:

478,796 x 23 x 4 = 44,049,232

44,049,232 x 0.0001 = $4,405

TARGHEE PASS - RECONSTRUCTION Traffic Benefits

HIGHWAY PROJECT ANALYSIS

Location of project Montana & Idaho County Gallatin & Fremont

Description of project Targhee Pass - West Yellowstone-Macks Inn

Highway number Mont. F.H. #46 Idaho F.H. #34 Highway system Forest Hwy. & Federal-Aid

Length 23.0 Date of analysis March, 1945

Mileage Element Factors

Item	Fuel Function	Non-fuel Function
Distance savings	$ 0	$ 0
Roadway surface savings	0	0
Rise and fall savings	164	
Gradient savings		
Alignment savings	2,203	2,202
Elimination of traffic stops		
Miscellaneous savings		
Total Mileage Savings	$2,367	$ 2,202

Time Element Factors

Type of Traffic	Annual Value of Time Savings
Passenger cars	$ 0
Trucks, light	1,388
Trucks, medium	215
Trucks, heavy	2,094
Busses	
Total Time Savings	$ 3,697

Other Benefit Items

Item	Value
	$
Total	$

Recapitulation of Annual Benefits

Total Fuel Function Benefits		$2,367
Non-fuel function benefits	(Mileage element factors $2,202	
	(Time element factors 3,697	
	(Other benefit items $	
Total Non-fuel Function Benefits		$5,899
TOTAL ANNUAL BENEFITS		8,266

TARGHEE PASS

MAINTENANCE & BETTERMENT ANALYSIS

TARGHEE PASS
MAINTENANCE & BETTERMENT

HIGHWAY PROJECT ANALYSIS

Location of project Montana & Idaho County Gallatin & Fremont

Description of project Targhee Pass - West Yellowstone - Macks Inn

Highway number Mont. FH #46
Idaho FH #34 Highway system Forest Hwy. & Federal-Aid

Length 23.0 miles Date of analysis March, 1945

Analysis made by P. L. Johnson Checked by

I_{ar} = \$ 22,317 K_1 = 1

C_a = \$ 25,877 K_2 = 0

B_n = \$ 2,950 K_3 =

B_f = \$ 1,183 K_2K_3 =

K_1C_a = \$ 25,877 $1-K_2K_3$ =

$Q_s = I_{ar}/K_1C_a = \frac{22317}{25877} = 0.86$

$Q_{Bn} = B_n/K_1C_a = \frac{2950}{25877} = 0.11$

$Q_{Bf} = B_f/K_1C_a = \frac{1183}{25877} = 0.05$

$Q'_s = Q_s - K_2K_3Q_{Bf} = Q'_s = Q_s$

$Q_c = 0.707\,(Q_s + Q_{Bn} + Q_{Bf}(1-K_2K_3)) = .707\,(0.86 + 0.11 + 0.05) = 0.72$

TARGHEE PASS
MAINTENANCE & BETTERMENT
HIGHWAY PROJECT ANALYSIS

ANNUAL COST
CALCULATIONS

Location of project Montana & Idaho County Gallatin & Fremont

Description of project Targhee Pass - West Yellowstone - Macks Inn

Highway number Mont. FH #46 Idaho FH #34 Highway system Forest Hwy. & Federal-Aid

Length 23.0 miles Date of analysis March, 1945

CAPITAL COSTS

Item	Net Cost	Gross* Cost	Amort. Period	Annual Capital Cost
Rights of way, easements, etc.	$	$		$
Clearing, grading, etc.				
Pavements and surfacing:				
Type ______, ______ Mi.				
Type ______, ______ Mi.				
Structures:				
Type ______, ______ Ft.				
Type ______, ______ Ft.				
Type ______, ______ Ft.				
Signs, lights, signals etc....				
Other Construction items:.....				
Unamortized cost old const....				
1. Total annual capital cost......		310,550	20yrs No Int.	$ 15,527

MAINTENANCE COSTS

Item	Net Cost	Gross** Cost
Pavements and roadway surfaces:		
Type ______, ______ Mi.	$	$
Type ______, ______ Mi.		
Roadbed, shoulders and right of way ______ Mi.		
Structures:		
Type ______, ______ Ft.		
Type ______, ______ Ft.		
Type ______, ______ Ft.		
Miscellaneous general maintenance		
Other items		$
2. Total annual maintenance cost 23 miles @ 450		$10,350

OPERATION COSTS

3. Additional mileage ______ at ______ per mile $ ______

TOTAL ANNUAL COSTS (1 + 2 + 3) $25,877

*Gross costs comprise net costs plus 10% for engineering and construction and 4% for general administration and overhead.

**Gross costs comprise net costs plus 6% for general administration and overhead expense.

TARGHEE PASS
MAINTENANCE & BETTERMENT
HIGHWAY PROJECT ANALYSIS DETAILS

Deficiency factor = 25%

Reconstruction cost = 621,100

621,100 x .25 = $155,275

Due to small quantities of work done each year the cost is assumed to increase 100%, thus cost will be $310,550 or an average of $15,527 per year for 20 years.

HIGHWAY PROJECT ANALYSIS

Traffic Income

Location of project Montana & Idaho Description of project Targhee Pass County Gallatin & Fremont

Highway Mont. FH #46 Idaho FH #34 Highway System Federal-Aid Forest Hwy. Length 23.0 Date of analysis March, 1945

Traffic Type	Average Annual Traffic				Average Annual Road Use During Life of Project		Unit Net Revenues		Total Annual Net Revenue
	Present		Projected				Per Vehicle Mi.	Per Ton Mile	
	Vehicles: 1941	Tons	Vehicles 1955	Tons	Veh. Miles	Ton Mi.	Dollars	Dollars	Dollars
Passenger Cars-~~Oregon~~ Mont	52,560	78,840	66,065	99,098	1,519,495	2,279,254	0.003391	0.002188	4,987
Cars - Foreign	43,435	65,153	54,750	82,125	1,259,250	1,888,875	0.002758	0.001779	3,360
Total passenger cars	95,995	143,993	120,815	181,223	2,778,745	4,168,129	--	--	8,347
Trucks, light	19,345	63,258	24,090	78,774	554,070	1,811,802	0.011044	0.003248	5,885
Trucks, medium	1,825	12,556	2,190	15,067	50,370	346,541	0.015480	0.002382	825
Trucks, heavy	--	--	365	4,070	8,395	93,610	0.016190	0.001619	152
Trucks, semi-trailer	9,855	146,740	12,410	184,785	285,430	4,250,055	0.015430	0.001543	6,558
Trucks, full-trailer	365	8,307	365	8,307	8,395	191,061	0.023732	0.001396	267
Busses, school	--	--	--	--	--	--	--	--	--
Busses, other	365	3,285	730	6,570	16,790	151,110	0.016857	0.001873	283
Total trucks & busses	31,755	234,146	40,150	297,573	923,450	6,844,179	--	--	13,970
Total all vehicles	127,750	378,139	160,965	478,796	3,702,195	11,012,308	--	--	22,317

Average weight of trucks 7.42 tons; All vehicles ______ tons. Total Annual Income....$22,317

Percentage truck traffic 25.0.

Amortization period 20 years.

TARGHEE PASS
MAINTENANCE & BETTERMENT
HIGHWAY PROJECT ANALYSIS

Time Element Savings

Location of project Montana & Idaho County Gallatin & Fremont
Description of project Targhee Pass - West Yellowstone - Macks Inn
Highway number Mont FH 46, Idaho FH 34 Highway System Forest Hwy., Federal-Aid
Length 23.0 miles Date of analysis March, 1945

	Routes		
	A NEW	B EXISTING	C
Annual Traffic Volume			
Private Passenger cars(per year)	120,815	120,815	
Trucks, light (per year)........	24,090	24,090	
Trucks, medium (per year).......	2,190	2,190	
Trucks, heavy (per year)........	13,870	13,870	
Busses (per year)...............			
Other traffic...................			
Totals....................			
Private Passenger Cars			
Average speed (miles per hour)..	43	43	
Distance (Miles)................	23	23	
Time (hours per trip)...........	.534	.534	
Time savings per vehicle........	0		
Value of savings($/vehicle-hour)	$0.60		
Annual traffic volume...........	120,815		
Value of time savings...........	0		
Total..................	$ 0		
Trucks, Light			
Average speed (miles per hour)..	39	35	
Distance (miles)................	23	23	
Time (hours per trip)...........	.590	.657	
Time savings per vehicle........	.067		
Value of savings ($/vehicle-hour)	$0.86		
Annual traffic volume...........	24,090		
Value of time savings...........	1,388		
Total..................	$ 1,388		
Trucks, Medium			
Average speed (miles per hour)..	35	31	
Distance (miles)................	23	23	
Time (hours per trip)...........	.657	.741	
Time savings per vehicle........	.084		
Value of savings ($/vehicle-hour)	$1.17		
Annual traffic volume...........	2,190		
Value of time savings...........	215		
Total..................	$ 215		
Trucks, Heavy			
Average speed (miles per hour)..	32	28	
Distance (miles)................	23	23	
Time (hours per trip)...........	.719	.821	
Time savings per vehicle........	.103		
Value of savings ($/vehicle-hour)	$1.47		
Annual traffic volume...........	13,870		
Value of time savings...........	2,094		
Total..................	$ 2,094		
Busses			
Average speed (miles per hour)..			
Distance (miles)................			
Time (hours per trip)...........			
Time savings per vehicle........			
Value of savings ($/vehicle-hour)			
Annual traffic volume...........			
Total..................	$		

Use only ½ of total as average for 20 yr. period

TOTAL ANNUAL TIME ELEMENT SAVINGS .... $ 3697 ÷ 1849

TARGHEE PASS
MAINTENANCE & BETTERMENT

Mileage Element Savings

HIGHWAY PROJECT ANALYSIS

Location of project Montana & Idaho County Gallatin & Fremont
Description of Project Targhee Pass - West Yellowstone - Macks Inn
Highway number Mont FH 46, Idaho FH 34 Highway system Forest Hwy. & Federal-Aid
Length 23.0 miles Date of Analysis March, 1945

	Routes		
	A NEW	B EXISTING	C
Distance			
Length (miles)....................	23	23	
Distance saving (miles)..........			
Average annual traffic (tons)....			
Annual traffic saving (ton-mi.)..			
Cost ($/ton-mile)................			
Annual saving....................			
Total....................	$		
Surface			
Roadway surface type.............	483	483	
Saving coefficient...............			
Aver. annual traffic (ton-mi.)...			
Saving ($/ton-mile)..............			
Annual Saving....................			
Total....................	$		
Rise and Fall			
Rise and fall (feet).............	1,749	1,799	
Saving (feet)....................	50		
Saving (foot-tons)...............	23,939,800		
Saving ($/foot-ton)..............	3.42×10^{-6}		
Annual saving....................	82		
Total....................	$ 82		
Gradient			
Gradients in per cent............			
Red'n in gradient................			
Average An. traffic (ton-mi.)....			
Saving ($/ton-mile)..............			
Annual saving....................			
Total....................	$		
Alignment			
Curvature rating.................	8	6	
Points improvement...............	2		
Saving (point-ton-miles).........	22,024,616		
Saving ($/point-ton-mile)........	0.0001		
Annual saving....................	2,203		
Total....................	$ 2,203		
Traffic Stops			
Number per year..................			
Eliminated per year..............			
Aver. vehicular weight (tons)....			
Saving ($ per ton-per stop)......			
Annual saving....................			
Total....................	$		

TOTAL ANNUAL MILEAGE ELEMENT SAVINGS $ 2,285

TARGHEE PASS
MAINTENANCE & BETTERMENT
MILEAGE ELEMENT SAVINGS DETAILS

Distance

Same both roads

Surface

Same both roads -- type 483

Rise & Fall

Since this work is to be done over a 25 year period the full benefit will not be obtained until the end of the period, when a rise and fall of 100 ft. will be eliminated. The average benefit will therefore be $\frac{100}{2}$ or 50 ft.

Gradient

Same for both roads

Alignment

25 year improvement will make a 4 pt. improvement. Average improvement will be 2 pt.

Traffic Benefits

TARGHEE PASS
MAINTENANCE & BETTERMENT
HIGHWAY PROJECT ANALYSIS

Location of project Montana & Idaho County Gallatin & Fremont

Description of project Targhee Pass - West Yellowstone - Macks Inn

Highway number Mont. FH #46 Idaho FH #34 Highway system Forest Hwy., Federal-Aid

Length 23.0 miles Date of analysis March, 1945

Mileage Element Factors

Item	Fuel Function	Non-fuel Function
Distance savings	$	$
Roadway surface savings		
Rise and fall savings	82	
Gradient savings		
Alignment savings	1,101	1,101
Elimination of traffic stops		
Miscellaneous savings		
Total Mileage Savings	$ 1,183	$ 1,101

Time Element Factors

Type of Traffic	Annual Value of Time Savings
Passenger cars	$
Trucks, light	694
Trucks, medium	108
Trucks, heavy	1047
Busses	
Total Time Savings	$ 1849

Other Benefit Items

Item	Value
	$
Total	$

Recapitulation of Annual Benefits

Total Fuel Function Benefits $1183

Non-fuel function benefits
(Mileage element factors $1101
(Time element factors 1849
(Other benefit items $

Total Non-fuel Function Benefits $950

TOTAL ANNUAL BENEFITS 4133